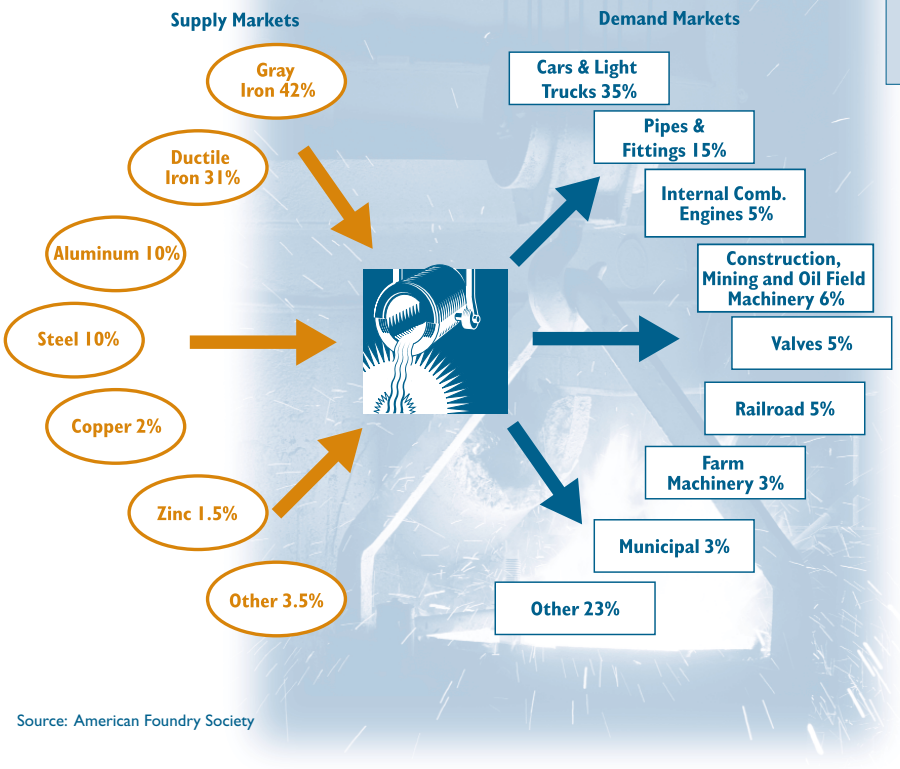
Cast metal products are essential to nearly all manufacturing industries. In the United States, approximately 2,950 foundries provide castings for 90% of manufactured durable goods and most manufacturing machinery. Major end-use markets include automotive, pipe, industrial machinery, transportation equipment, and aerospace.

PROFILE

Metalcasting Industry

Value of Shipments	$18 billion
Employment	227,100
Capital Expenditures	$1.35 billion
Net Trade Balance	$117 million
Net Energy Consumption	200 trillion Btu

METALCASTING SUPPLY AND END-USE MARKETS, 1998



Source: American Foundry Society

PRODUCTION TRENDS

The metalcasting industry has been making a comeback after major declines in the 1980s. Although the industry had achieved record production levels of almost 20 million tons by the late 1970s, casting production declined significantly during the 1980s. This decline was due to decreased demand for cast products, increased foreign competition, and increased use of substitute materials such as plastics, ceramics, and composites. By 1990, U.S. metalcasting production had dropped to 11.3 million tons.

The U.S. metalcasting industry has seen a resurgence in the 1990s. In 1998, the United States shipped approximately 14.1 million metric tons valued at $18 billion. The United States is now the world's leading producer of metalcastings. This recovery is due to a variety of factors, including improved domestic and international demand.

Despite a continued strong economy in the United States, a weaker global economy is expected to affect exports of metalcastings. On a *volume* basis, industry production is expected to grow 1.7% annually between 2001 and 2008, when casting shipments are expected to total approximately 17.7 million tons. On a *value* basis, however, casting sales are expected to grow 4.7% during that period, with lighter and more expensive casting dominating the market.

EMPLOYMENT

Metalcasters are predominantly small businesses. Eighty percent of U.S. foundries employ fewer than 100 workers each, and only 6% employ more than 250 workers. Foundries are located throughout the country but are primarily concentrated in the Midwest and Southeast. The metalcasting industry employs approximately 227,100 workers with a payroll of $7 billion.

COMPETITION

The U.S metalcasting industry faces tough competition from foreign metalcasters and suppliers of alternative materials. Foreign competitors can offer lower product costs due to lower wage scales and less stringent environmental standards. Environmental constraints and the disposal of pollution and waste products are costing the U.S. industry more each year, cutting into profits. In addition, demand for lightweight products has increased the use of alternatives to cast metal, such as plastics and other materials.

ENERGY USE

Metalcasting is among the most energy-intensive industries in the United States. According to Department of Energy figures, 15% to 25% of production cost is related to the use of energy. The metalcasting industry consumes an estimated 200 trillion Btu annually. More than half of this energy is used in melting.

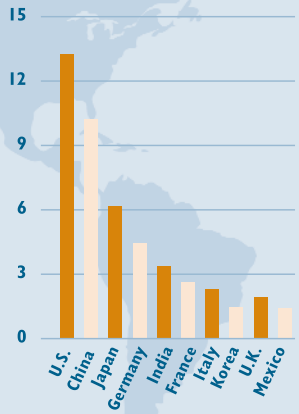
ENVIRONMENT

The metalcasting industry is a leader in both recycling and reusing scrap materials, and is responding to tougher environmental standards. Today, the industry invests more than $1.25 billion annually to meet environmental regulations and to develop pollution prevention technologies.

RECYCLING

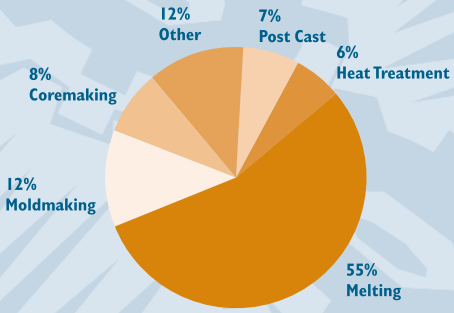
The metalcasting industry is exceptional in its reuse of scrap metal to produce new goods. The industry obtains 85% of its feedstock for ferrous castings from scrap—about 13.3 million tons or $1 billion worth of scrap metal. In addition, the industry is finding new ways to recycle spent sand and to recover and reuse metals, chemicals, and other waste products.

CASTING SHIPMENTS OF TOP TEN METALCASTING COUNTRIES BY MILLIONS OF METRIC TONS, 1998



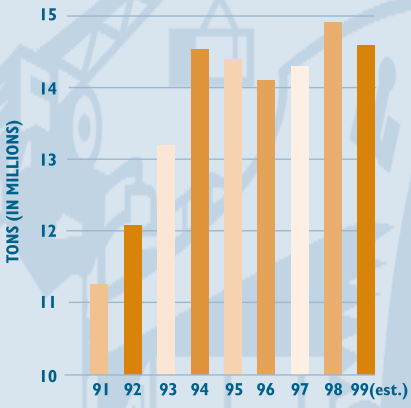
Source: American Foundry Society

BREAKDOWN OF PROCESS ENERGY COSTS, 1997



Source: Bates 1997

TOTAL U.S. CASTING SHIPMENTS, 1991-1998



Source: American Foundry Society, Modern Casting, January 1998 and December 1997.

Industry Vision and Roadmap

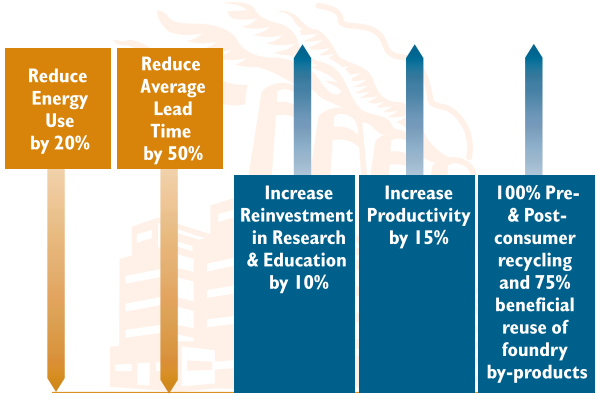
METALCASTING INDUSTRY VISION

In September 1995, the metalcasting industry—represented by the American Foundry Society, the North American Die Casting Association, and the Steel Founder's Society of America—published a unified and focused vision of its future. This document, *Beyond 2000: A Vision for the American Metalcasting Industry*, sets broad industry goals and performance targets for the next 20 years.

According to the vision, the industry aims to

- Be the preferred supplier of net or near-net shape metal components
- Produce products in an efficient, environmentally friendly manner
- Have products considered necessary "engineered components" rather than commodities

GOALS FOR THE METALCASTING INDUSTRY OF THE FUTURE



Source: Beyond 2000, A Vision for the American Metalcasting Industry

The document also identifies key R&D needs to achieve these goals. Priority research areas include Products and Markets, Materials Technologies, Manufacturing Technologies, and Environmental Technologies. Additional focus areas include Human Resources, Profitability and Industry Health, and Partnerships and Collaboration.

METALCASTING INDUSTRY ROADMAP

While *Beyond 2000* identifies performance targets, the *Metalcasting Industry Technology Roadmap*, published in January 1998, presents a detailed technology strategy to achieve the vision goals. Key research areas identified in the vision are important components of this strategy.

The roadmap details current status, critical trends, and driving forces affecting each technology area. It also identifies vision performance targets, barriers to reaching targets, and R&D activities needed to overcome these barriers.

In addition, the roadmap sets goals for educating and training the workforce, attracting and retaining quality personnel, addressing increased foreign competition, and responding to regulatory requirements.

HIGH-PRIORITY RESEARCH NEEDS FROM THE METALCASTING INDUSTRY ROADMAP

Products and Markets	Materials Technologies	Manufacturing Technologies	Environmental Technologies
• Transform foundries to tier-one suppliers • Develop computer design tools to move from design concept to a design for manufacturing • Develop methods to encourage/systematize concurrent engineering partnerships within the metalcasting industry • Develop ways to demonstrate the quality and value of castings • Develop tools and technologies to reduce lead times in the metalcasting industry	• Develop quantitative relationships among alloy chemistries, properties, and processing • Establish standard methodologies for materials testing • Develop a clean melting and remelting process • Develop methods for fast, accurate, and non-destructive evaluation of ingot and as-cast chemistries and properties (particularly for ferrous casting) • Develop improved technologies to measure the acceptability of liquid metal prior to casting • Develop a national initiative to foster interest in materials science and engineering	• Develop low-cost rapid tooling technology • Improve tooling design to reduce the time to move castings to market • Develop cost-effective and dimensionally accurate patternmaking processes for use in sand casting • Improve the ability to produce size/dimension • Develop smart controls and sensors for automation supervision • Develop a systems approach to scheduling and tracking • Figure out how die casting molds/dies actually fill • Understand folds for aluminum lost foam casting • Develop melting and pouring technologies that do not introduce gases to the process • Develop a mathematical model that describes process control and can control the machine	• Develop environmentally benign, dimensionally stable molding materials for sand casting • Develop new uses for waste streams and/or new ways to treat wastes to make them more usable • Develop emissions database for foundries to use in educating regulators

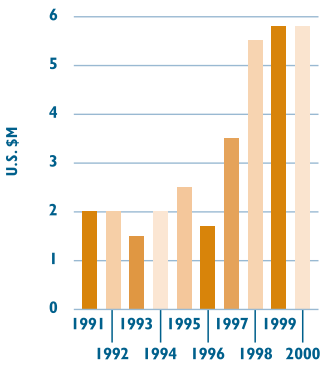
Team & Partnership Activities

The Department of Energy's Office of Industrial Technologies has established a highly successful partnership with the metalcasting industry. This industry-government partnership, the Metal Casting Industry of the Future, is coordinated through the Cast Metals Coalition (CMC). The CMC is composed of the American Foundry Society (AFS), North American Diecasting Association (NADCA), the Steel Founders' Society of America (SFSA) and the Advanced Technology Institute (ATI). Collectively, this coalition represents the majority of the U.S. metalcasting industry.

Metalcasting research projects are selected through a competitive solicitation process. In coordination with CMC, OIT solicits research projects that address national energy goals as well as priority needs of the metalcasting industry as outlined in the roadmap. All proposals must undergo a Technical Merit Review. The results are provided to the OIT Metalcasting Team, which then makes the final project selections.

The vast majority of metalcasting research is performed by the researchers, educators, and students at over 20 universities and laboratories. This arrangement addresses a high-priority concern of the industry—the future availability of a well-trained labor force. Since the program's inception, the number of OIT partners from the metalcasting industry itself has increased significantly. In 1991, the program's first year, partners from industry, academia, and state government numbered 50. Today, more than 250 industry partners from 30 states provide critical technical and cost-shared support.

FUNDING SUPPORT FOR METALCASTING RESEARCH AND DEVELOPMENT THROUGH DOE'S OFFICE OF INDUSTRIAL TECHNOLOGIES

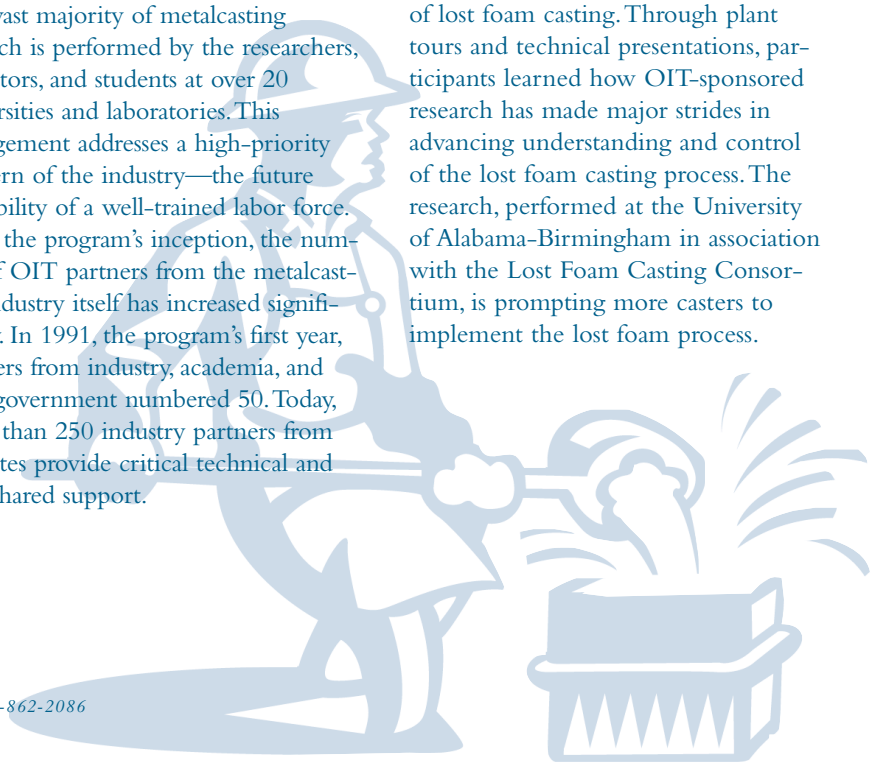


Industry and government partners review research projects on a regular basis to monitor progress. Research results are widely disseminated through various means, including conferences, journals, and workshops. Over the last three years, for example, over 70 articles on OIT-funded research have appeared in industry publications.

Along with increased program participation, indications of success include additional funding from Congress. Funding support for metalcasting R&D through OIT increased from $2 million in 1991 to over $5 million in 2000.

A technology showcase held in November 1999 at Lester Precision Diecasting in Twinsburg, Ohio, highlighted the progress of OIT's cost-shared research for the metalcasting industry. Plant tours, poster presentations, and seminars highlighted the results of 11 OIT-sponsored research projects. Visitors saw firsthand how these projects are helping to save energy while improving productivity and quality. Joseph Ponteri, President and CEO of Lester's parent company, GMTI, stated that "these technologies are assisting Lester Precision Die Casting in achieving world class status as a leading die casting company."

In October 1998, a showcase in Birmingham, Alabama, highlighted the energy, environmental, and cost advantages of lost foam casting. Through plant tours and technical presentations, participants learned how OIT-sponsored research has made major strides in advancing understanding and control of the lost foam casting process. The research, performed at the University of Alabama-Birmingham in association with the Lost Foam Casting Consortium, is prompting more casters to implement the lost foam process.



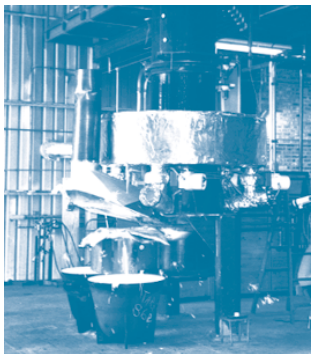
REPRESENTATIVE METALCASTING-RELATED PROJECTS IN OIT'S PORTFOLIO

	MATERIALS TECHNOLOGIES	MANUFACTURING TECHNOLOGIES	PRODUCTS & MARKETS	ENVIRONMENTAL TECHNOLOGIES
Metalcasting Industry				
•Advanced Lost Foam Technology		●		
•Clean Cast Steel	●	●		
•Clean Metalcasting	●			
•Consistent Casting of High-Strength Ductile Iron		●	●	
•Die Life Extension	●	●		
•*Energy Saving Manual* with Software				●
•Intelligent Control of the Cupola Furnace		●		●
•Macro-Inclusions Atlas	●			
•Semi-Solid Aluminum Alloys	●			
•Steel Foundry Refractory Lining Optimization				●
•Thin Section Steel Castings			●	
•Unconventional Yield Studies		●		
•Cast View		●		
Industrial Materials				
•Advanced Intermetallic Alloys	●			
•Ceramic Composite for Metal Casting	●			
Inventions and Innovation				
•Filtering Molten Metal			●	
•A Safer, Effective Resin Produced from Recycled Waste				●
NICE^3				
•Atmosphere Recovery and Regeneration in Heat Treating				●
•High-Temperature Materials for Die Cast Copper Rotors	●			
•In-Situ, Real Time Measurement of Melt Constituents		●		
•Integrated Advance Oxidation—Underwater Plasma Processing				●
•A Process to Recover and Reuse Sulfur Dioxide				●
Sensors and Controls				
•Sensing and Control of the Cupola Furnace		●		
Other IOF				
•High-Efficiency, High-Capacity, Low NOx Melting		●		
•Improved Grain Refinement Process	●			
•Prevention of Molten Water Explosions		●		

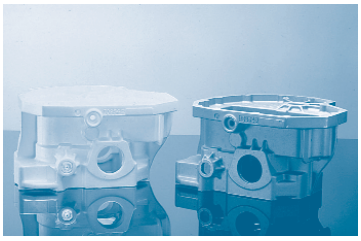
See "Selected Metalcasting Portfolio Highlights" on the next two pages for additional information

Selected Metalcasting Portfolio Highlights

There are significant market opportunities for high-strength, thin-wall steel castings.

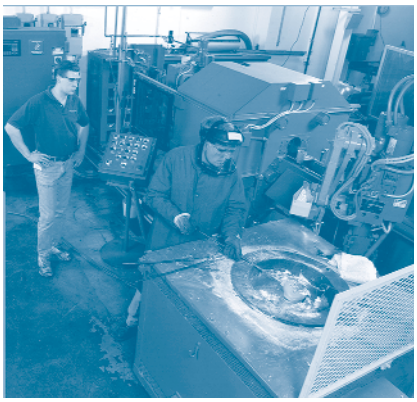


An integrated sensing and control system improves the productivity of cupola furnaces.

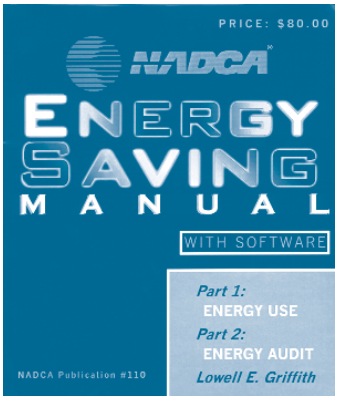


Aluminum transmission housing component with cast-in brass insert produced by lost foam process.

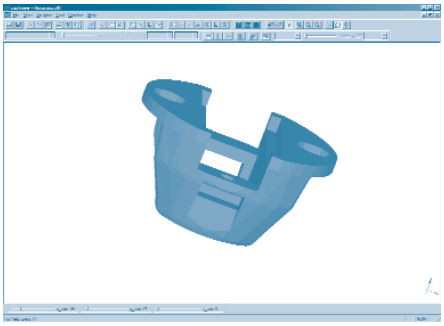
AREA	MATERIALS TECHNOLOGIES	MANUFACTURING TECHNOLOGIES	MANUFACTURING TECHNOLOGIES
PROJECT	**Clean Cast Steel Technology**	**Intelligent Control of the Cupola Furnace**	**Advanced Lost Foam Casting**
DESCRIPTION	All foundries have oxide macroinclusions in their regular production castings. Macroinclusions can significantly degrade the machining of parts – even to the point of breaking tools. This research, being performed by the University of Alabama - Birmingham in conjunction with the Steel Founders' Society of America is helping to identify the causes of inclusions and minimize or eliminate their occurrence. In one foundry for example, the number of welds requiring repair dropped from an average of 21.1 per casting to 3.7 per casting.	Although the cupola furnace has historically been the primary method for melting iron, variability in cupola output and pollution have contributed to its recent decline in the domestic market. An integrated sensing and control system called I³PSC will enhance environmental performance and optimize output for cupola furnaces by regulating melt rate, temperature, and iron composition. The technology will increase energy efficiency and cast yield while decreasing coke requirements by up to 3.4 million tons annually with a similar reduction in carbon emissions.	The lost foam casting process eliminates cores and core boxes and provides improved control of casting wall thickness. The process has significant cost and environmental advantages and enables metalcasters to produce increasingly complex parts. To ensure consistently high-quality castings, researchers from the University of Alabama, the Cast Metals Coalition, and the American Foundry Society are sponsoring development of new process control measures, which will lead to improved analysis and control in each stage of the process. These measures are resulting in higher-quality castings, more cost- and energy-efficient foundry operations, and dramatic reductions in scrap.
PARTNERS	Steel Founder's Society of America University of Alabama - Birmingham Over 20 industry partners	American Foundry Society Idaho National Engineering and Environmental Laboratory Tennessee Technological University Utah State University and several companies	American Foundry Society University of Alabama



Die casting research facility



The Energy Saving Manual *helps die casting plants identify opportunities for saving energy.*



CastView™ identifies die casting design problems in the design phase, saving energy and materials.

MANUFACTURING TECHNOLOGIES

Die Life Extension

Die production is a significant cost for the die casting industry. Researchers at Case Western Reserve University and industry partners are studying the effects of steel chemistry, heat treatment, and electro-discharge machining on the lifetime of dies for die casting. Extension of die life could result in annual savings of over $200 million. Additional benefits of die life extension include reduced down-time associated with die production, as well as reduced energy consumption and emissions associated with die production. The results of this project have already saved $1 million in die replacement costs.

Case Western Reserve University,
Badger Metals Tech, CMI, Crown Equipment Corp., Harvard Industries, ITT Automotive, Lindberg, Universal, North American Die Casting Association

ENVIRONMENTAL TECHNOLOGIES

Energy Saving Manual with Software

Die casting plants can minimize energy waste by implementing energy-efficient best practices. L.E. Griffith Associates, the North American Die Casting Association, and Stroh Die Casting developed a manual that contains data on direct metalcasting energy usage and describes procedures to minimize this energy use.

The *Energy Saving Manual* analyzes use of process and non-process energy throughout the plant. It also describes the most energy-efficient practices for each area. Spreadsheets are included to calculate energy use.

L.E. Griffith Association
North American Die Casting Association
Stroh Die Casting

MANUFACTURING TECHNOLOGIES

CastView™

Reducing the number of die try-outs can reduce energy and scrap use as well as development lead times. CastView™ is a PC-based modeling program for die casting flow simulation. It is based on a qualitative analysis of part geometry, which yields extremely fast analysis times. This visualization tool is being used in the design stage to evaluate candidate gate, vent, and overflow locations and to quickly compare candidate designs. CastView™ is now available commercially from NADCA.

North American Die Casting Association
Ohio State University

For more information on OIT's Metalcasting Portfolio, visit www.oit.doe.gov/metalcast